PATENT ABSTRACTS OF JAPAN

(11)Publication number : 05-009740

(43)Date of publication of application : 19.01.1993

(51)Int.Cl. C23C 16/46
C23C 14/50
H01L 21/203
H01L 21/205
H01L 21/285
H01L 21/302
H01L 21/31

(21)Application number : 03-253678

(22)Date of filing : 01.10.1991

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(30)Priority

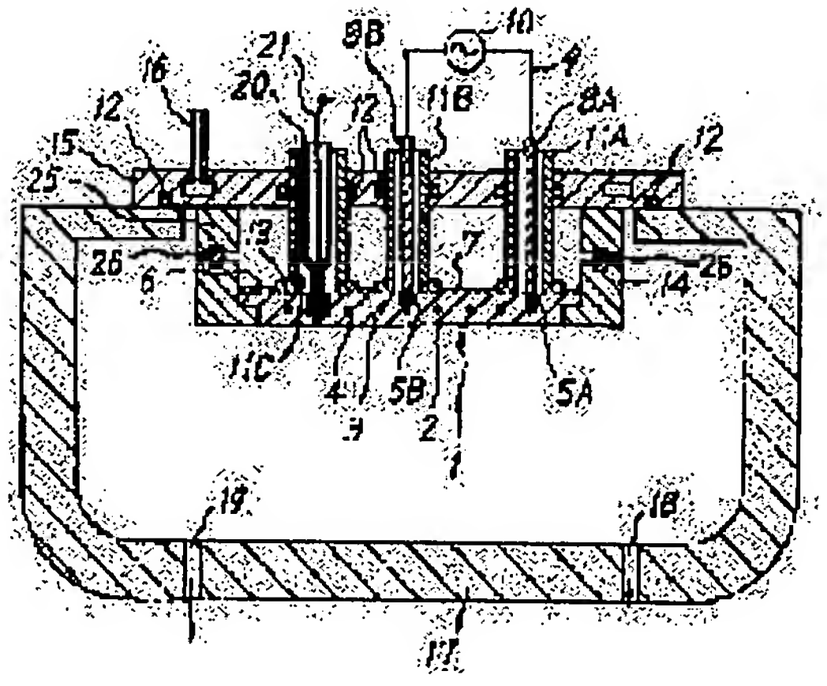
Priority number : 03 84575 Priority date : 26.03.1991 Priority country : JP

(54) SEMICONDUCTOR WAFER HEATING DEVICE

(57)Abstract:

PURPOSE: To prevent such contamination as in the case of the conventional metallic heaters and to solve such problems as the poorness in thermal efficiency and film sticking to an IR transmission window as in the case of an indirect heating system, as well as to prevent the corrosion of electrode members and the electric discharge and leakage between the electrode members and between the electrode members and a case.

CONSTITUTION: A resistance heating element 4 is embedded into a disk-shaped ceramic base body 3. Lumped terminals 5A, 5B are respectively connected to, for example, the round bar-shaped electrode members 8A, 8B. A thermocouple 21 is housed into a hollow sheath 20 and the front end of the hollow sheath 20 is



inserted into the insertion hole of the ceramic base body 3 and is joined thereto. The hollow sheath 20 may be emitted. Insulating cylindrical bodies 11A, 11B, 11C are airtightly connected to the ceramic heater and are inserted into the through-holes of a flange 15. The cylindrical bodies 11A, 11B, 11C and the flange 15 are airtightly sealed from each other.

LEGAL STATUS

[Date of request for examination]	25.06.1993
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	2525974
[Date of registration]	31.05.1996
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline sectional view showing the condition of having attached the semi-conductor wafer heating apparatus concerning the example of this invention in the container.
[Drawing 2] It is the important section expanded sectional view of drawing 1 .
[Drawing 3] It is the outline sectional view showing the condition of having attached the semi-conductor wafer heating apparatus concerning other examples of this invention in the container.
[Drawing 4] It is the outline sectional view showing the condition of having attached the semi-conductor wafer heating apparatus concerning the example of further others of this invention in the container.
[Drawing 5] It is the expanded sectional view showing the circumference of cylindrical object 11C in the heating apparatus of drawing 4 .
[Drawing 6] It is the outline sectional view showing the condition of having attached the semi-conductor wafer heating apparatus concerning the example of further others of this invention in the container.
[Drawing 7] It is the sectional view showing a condition just before joining cylindrical object 11C to the ceramic base 3.
[Drawing 8] It is the outline sectional view showing the condition of having attached in the container the semi-conductor wafer heating apparatus concerning the example of reference which this invention person developed.
[Description of Notations]
12 o-ring
1 Ceramic Heater
2 Wafer Heating Surface
3 Disc-like Ceramic Base
4 Resistance Heating Element
5A, 5B Massive terminal
6 Heater Tooth Back
7 Conductive Deposition Film
8A, 8B Round bar-like electrode member
9 Lead Wire
11A, 11B, 11C Cylindrical object
14 Case (Example of Attachment Component)
15 Flange of Container
17 Body of Container
20 Hollow Sheath
21 Thermocouple
30 Insertion Hole

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the semi-conductor wafer heating apparatus used for plasma CVD, reduced pressure CVD, plasma etching, optical etching, a sputtering system, etc.
[0002]
[Description of the Prior Art] With the equipment for semi-conductor manufacture which needs a super clean condition, corrosive gas, such as chlorine-based gas and fluorine system gas, is used as corrosive gas, the gas for etching, and gas for cleaning. For this reason, if the conventional heater which covered the front face of a resistance heating element with metals, such as stainless steel and Inconel, is used as heating apparatus for heating a wafer in the condition of having made these corrosive gas contacting, it is the particle size of several micrometers of a chloride, oxide, fluoride, etc. by exposure of these gas. The particle which is not desirable occurs.
[0003] Then, an infrared lamp is installed in the outside of the container exposed to the gas for deposition etc., an infrared transparency aperture is prepared in a container outer wall, infrared radiation is emitted to the heated object which consists of the quality of the material with good corrosion resistance, such as graphite, and the wafer heating apparatus of the indirect heating method which heats the wafer put on the top face of a heated object is developed. However, as compared with the thing of a direct heating type, infrared transparency was gradually barred by adhesion of the CVD film to that heat loss is large, that a temperature rise takes time amount, and an infrared transparency aperture, and the thing of this method had problems, like heat absorption arises by the infrared transparency aperture, and an aperture is overheated.
[0004]
[Problem(s) to be Solved by the Invention] In order to solve such a problem, this invention person developed previously heating apparatus as roughly shown in drawing 8 . In drawing 8, the body of the container with which 17 is used for CVD for semi-conductor manufacture, and 1 are the disc-like ceramic heaters for wafer heating attached in the case 14 of the interior, and let magnitude of the wafer heating surface 2 be the size which can install a wafer as 4-8 inches. The case attaching ring 25 is fixed to the flange 15 bottom, and a case 14 is fixed to the ring 25 bottom for case anchoring through the heat insulation ring 26. The clearance between some is prepared between the case attaching ring 25 and a case 14, and both take care not to contact directly. The gas for Heat CVD is supplied to the interior of the body 17 of a container from the gas supply hole 18, and internal air is discharged by the vacuum pump from the suction hole 19. The disc-like ceramic heater 1 lays the resistance heating elements 4, such as a tungsten system, under the interior of a disc-like ceramic base [that it is precise and gas tight] 3 like silicon nitride in the shape of a spiral.
[0005] The massive terminals 5A and 5B of a pair are formed in the tooth-back 6 side of the disc-like ceramic base 3, and these massive terminals 5A and 5B are connected to the resistance heating element 4. The end of the rod-like electrode members 8A and 8B is connected with the massive terminals 5A and 5B, respectively. Each electrode members 8A and 8B are inserted in the through tube of the flange 15 of

a container, and the seal of each electrode members 8A and 8B and the flange 15 is airtightly carried out with O ring 12. Lead wire 9 is connected to the other end of each electrode members 8A and 8B, respectively, and the lead wire 9 of a pair is connected to AC power supply 10. Power is supplied to the resistance heating element 4 through the electrode members 8A and 8B of a pair, and the disc-like ceramic heater 1 is heated at about a maximum of 1100 degrees C. The top face of a case 14 is covered by the flange 15 which formed the water cooled jacket 16, the seal of a flange 15 and the wall surface of the body 17 of a container is airtightly carried out with O ring 12, and a flange 15 constitutes the head-lining wall surface of a container.

[0006] 20 is the hollow sheath which penetrated the wall surface of such a flange 15 and was inserted in the interior of a container, and is joined to the ceramic heater 1. The thermocouple 21 with a stainless steel sheath is inserted in the interior of the hollow sheath 20. The O ring was prepared between the hollow sheath 20 and the flange 15, and an atmospheric invasion is prevented.

[0007] However, when such semi-conductor wafer heating apparatus was actually used for semiconductor fabrication machines and equipment, it turned out that the still following problems occur. That is, if the gas for CVD is supplied, it will invade into the heater tooth-back 6 side unescapable, and the deposition film 7 will generate at the hot heater tooth back 6. Since the deposition film 7 made from this metal is conductivity, the electrode members 8A and 8B of a pair short-circuit it (short), and it becomes impossible to use the ceramic heater 1.

[0008] Moreover, this invention person formed the electrode members 8A and 8B with the strong tungsten etc. to corrosion. However, when this heating apparatus is used in the semiconductor fabrication machines and equipment using etching gas for a long period of time, the corrosion of the electrode members 8A and 8B progresses, and it is the ceramic heater 1. There was a case where the engine performance deteriorated. Moreover, the problem is left behind to the thermocouple 21 side. First, the reason for having formed the hollow sheath 20 is explained. According to research of this invention person, it understands that the behavior of the gas molecule around a thermocouple is in a viscous flow region in the vacua of atmospheric pressure - 1torr especially in in a vacuum, but an exact thermometry becomes impossible since it will shift to a molecular flow region if a degree of vacuum increases, and the mode of the heat transfer in the perimeter of a thermocouple changes sharply in connection with this. Moreover, also in the viscous flow region, when pressure fluctuation is large, it turns out that a thermometry error exists. this invention person held the thermocouple 21 into the hollow sheath 20 in order to prevent this. This hollow sheath was formed with refractory metals, such as molybdenum. However, in semiconductor fabrication machines and equipment, in order to use an RF generator and a high voltage power supply, **** and induction took place and it turned out that thermometry precision may fall.

[0009] The technical problem of this invention is offering the semi-conductor wafer heating apparatus which can prevent contamination like [in the case of the conventional metal heater], and can also prevent the corrosion of the electrode member in the heating apparatus which did not produce a problem like film adhesion in the badness or the infrared transparency aperture of thermal efficiency like [in the case of an indirect heating method], but this invention person's moreover developed previously, discharge between between electrode members, an electrode member, and a case, and a short circuit.

[0010] Moreover, the technical problem of this invention is preventing the fall of the thermometry precision in the heating apparatus which could prevent contamination like [in the case of the conventional metal heater], and did not produce a problem like film adhesion in the badness or the infrared transparency aperture of thermal efficiency like [in the case of an indirect heating method], but this invention person's moreover developed previously.

[0011]

[Means for Solving the Problem] This invention comes to lay a resistance heating element underground into a ceramic base. The ceramic heater which two or more terminals connected to this resistance heating element have exposed to fields other than a wafer heating surface; in order to hold this ceramic heater The electrode member of the shape of a long picture by which the attachment component installed in the container and; end were connected with said terminal; It is the semi-conductor wafer heating

apparatus which has the lead wire connected to the other end of this electrode member. At least one of said electrode members is surrounded with the tube-like object which consists of a minerals insulating material. The end of this tube-like object is airtightly joined to said ceramic base, said tube-like object is inserted in the through tube prepared in said container, and the semi-conductor wafer heating apparatus which is carrying out the seal of between said containers and said tube-like objects airtightly is started.
[0012] Moreover, this invention comes to lay a resistance heating element underground into a ceramic base. The ceramic heater which two or more terminals connected to this resistance heating element have exposed to fields other than a wafer heating surface; in order to hold this ceramic heater The attachment component installed in the container; It is the semi-conductor wafer heating apparatus which has the thermometry machine with which the end was inserted into said ceramic base. Said thermometry machine is surrounded with the tube-like object which consists of a minerals insulating material. The end of this tube-like object is joined to said ceramic base, said tube-like object is inserted in the through tube prepared in said container, and the semi-conductor wafer heating apparatus with which the seal of between said containers and said tube-like objects is carried out airtightly is started.
[0013]
[Example] The outline sectional view and drawing 2 which show the condition that drawing 1 attached the heating apparatus concerning one example of this invention in the container are the important section expanded sectional view of drawing 1 . The same sign may be given to the same function part material as the member shown in drawing 8 , and the explanation may be omitted. First, cylindrical object 11A, 11B, and 11C are prepared. The ring-like flange 13 is formed in the pars basilaris ossis occipitalis of each cylindrical object 11A, 11B, and 11C. About these quality of the materials and processes, it mentions later.
[0014] It is joined to the heater tooth back 6, and the junction unification of the pars basilaris ossis occipitalis of cylindrical object 11A, 11B, and 11C is carried out with the disc-like ceramic base 3. In this example, a circular through tube is prepared in a flange 15 by three places, and cylindrical object 11A, 11B, and 11C are inserted in each circular through tube, respectively. The upper limit side of each cylindrical object 11A, 11B, and 11C is exposed out of a container, and the space in a cylinder of each cylindrical object 11A, 11B, and 11C is filled according to the ambient atmosphere outside a container. The seal of the pars basilaris ossis occipitalis and the disc-like ceramic base 3 of each cylindrical object 11A, 11B, and 11C is carried out airtightly, the hermetic seal of between each cylindrical object 11A, 11B, 11C, and a flange 15 is carried out with O ring 12, and, also electrically, it is insulated.
[0015] Each electrode members 8A and 8B are connected with the massive terminals 5A and 5B, respectively. About this connection approach, it mentions later. Electrode member 8A is fixed to the space in a cylinder of cylindrical object 11A, and electrode member 8B is being fixed to the space in a cylinder of cylindrical object 11B. In this example, the hollow sheath 20 which inserted the thermocouple 21 as a thermometry machine is used, and it is cylindrical object 11C about this hollow sheath 20. It fixes to the space in a cylinder. Thereby, the electrode members 8A and 8B of a pair, the massive terminals 5A and 5B of a pair, and the hollow sheath 20 are put to the ambient atmosphere outside a container by each.
[0016] According to this example, even if the conductive deposition film 7 generates at the heater tooth back 6, this deposition film 7 is intercepted with the cylindrical objects 11A and 11B, and the electrode members 8A and 8B do not short-circuit. Moreover, there is also no fear of discharge between the electrode members 8A and 8B and a container and a short circuit. Furthermore, since the electrode members 8A and 8B are not exposed to the space in a container, neither the corrosion of the electrode members 8A and 8B or the massive terminals 5A and 6B nor the contamination in the container by this is also produced. Moreover, since the electrode members 8A and 8B are not exposed to corrosive gas, the necessity which chooses the tungsten with a small diffusion coefficient to a semi-conductor wafer as an ingredient of the electrode members 8A and 8B is lost. For this reason, the electrode members 8A and 8B can be formed now with other ingredients.
[0017] Moreover, since the hollow sheath 20 which consists of molybdenum etc. is not exposed to the building envelope of a container, the possibility of contamination by such heavy metal also disappears.

Moreover, the thermocouple 21 in the hollow sheath 20 can be insulated by cylindrical object 11C which consists of a minerals insulating material. For this reason, since **** by the RF generator and high voltage power supply which are used with a semiconductor device, and induction were prevented, much more highly precise temperature measurement became possible. And since each forms the ring-like flange 13 in the lower limit of the cylindrical objects 11A, 11B, and 11C, the touch area of the tooth back 6 of the ceramic base 3 and the cylindrical objects 11A, 11B, and 11C can be enlarged, and both junction force can be enlarged enough.

[0018] As the quality of the material of the disc-like ceramic base 3, silicon nitride, sialon, an alumina, alumimium nitride, etc. are desirable, and silicon nitride and sialon are still more desirable in respect of thermal shock resistance. The seal between the flange 15 of a container, and each cylindrical object 11A, 11B and 11C can be based on metal packing besides the O ring shown in drawing 1 etc. The wafer heating surface 2 is 500 micrometers about flatness, when considering as a smooth side is desirable and a wafer is directly set especially to the wafer heating surface 2. It considers as the following and it is necessary to enable it to heat a plate-like wafer efficiently. as the resistance heating element 4 -- high-melting -- it is -- moreover -- Si3N4 etc. -- it is appropriate to use the tungsten excellent in adhesion, molybdenum, platinum, etc.

[0019] As the quality of the material of cylindrical object 11A, 11B, and 11C, the substantia-compacta ceramics is desirable. Since there is no differential thermal expansion of both when it is the same quality of the material especially as the disc-like ceramic base 3, the residual stress in a part for the joint after joining both decreases. Thereby, dependability becomes high about both bonding strength.

[0020] In order to join cylindrical object 11A, 11B, 11C, and the disc-like ceramic base 3, it is based on the following approaches.

(1) Sinter [ordinary-pressure-] or sinter [hotpress-] the ceramic heater 1, and lay beforehand massive terminal 5A, 5B, and the resistance heating element 4 underground into the Plastic solid in that case. Then, by injection molding, extrusion molding, press forming, and isostatic hydrostatic pressing, a cylinder-like Plastic solid is produced, ordinary pressure sintering of this is carried out, and cylindrical object 11A, 11B, and 11C are produced. Each cylindrical object 11A, 11B, and 11C are airtightly joined to the predetermined location of the disc-like ceramic base 3. Soldering using a titanium vacuum evaporationo golden wax, titanium vacuum evaporationo silver solder, etc. as this junction approach and glass junction is desirable. A part especially for a joint has the desirable one where that transition temperature is higher enough, and it is desirable to use quartz glass and oxy-night RAIDO glass for glass junction for this reason.

(2) Fabricate the Plastic solid for ceramic heater 1, and the cylindrical objects 11A and 11B and the Plastic solid for 11C by extrusion molding, injection molding, press forming, isostatic hydrostatic pressing, etc. according to an individual, respectively. Ordinary pressure sintering of each of these Plastic solids is carried out by ** ME ** I which gave the 1/100 -10mm dimensional tolerance, or pressure sintering of the Plastic solid for circle tube-like objects is pushed and carried out to the Plastic solid for heaters by sufficient pressure.

[0021] Drawing 3 is the outline sectional view showing the condition of having attached the heating apparatus concerning other examples of this invention in semiconductor fabrication machines and equipment. The same sign may be given to the same function part material as what was shown in drawing 1 , and the explanation may be omitted.

[0022] In this example, the direction of one electrode member 8A is not protected with a cylindrical object, but protects the electrode member 8B of another side by cylindrical object 11B. The electrode members 8A and 8B are connected to a coil 22 through lead wire 9, respectively. On the other hand, AC power supply 10 is connected to a coil 23 through lead wire 9. Coils 22 and 23 are made to counter and the double volume type isolation transformer 24 is constituted. Power is supplied to the resistance heating element 4 through this isolation transformer 24. Let secondary electrode member 8A and 8B be floating to AC power supply 10 of the upstream in this isolation transformer. The body 17 of a container is grounded.

[0023] According to this example, since it is protected and the direction of electrode member 8B is

insulated by cylindrical object 11B, discharge and a short circuit are not produced among the electrode members 8A and 8B. Moreover, even if the deposition film 7 is formed between electrode member 8A, and a case 14 and a flange 15, the ground during this period is not produced.
[0024] 1000-sheet heat CVD processing of the silicon wafer was carried out using the heating apparatus of drawing 1 and drawing 3 . AC-power-supply electrical potential difference It was referred to as 200V. Silicon nitride was used as the quality of the material of the disc-like ceramic base 3, the cylindrical objects 11A and 11B, and 11C. The tungsten was used as the quality of the material of the resistance heating element 4, the massive terminals 5A and 5B, and the electrode members 8A and 8B. Consequently, the short circuit from electrode member 8A and 8B was not observed.
[0025] The sectional view and drawing 5 which show the condition that drawing 4 attached the heating apparatus concerning the example of further others of this invention in the container are the partial enlarged drawing of drawing 4 . The same sign is given to the same member as the member shown in drawing 1 , and the explanation is omitted.
[0026] In this example, the hollow sheath 20 was omitted in the equipment of drawing 1 . And the long and slender insertion hole 30 which carries out opening is formed in the tooth back 6 of the ceramic base 3, and the tip of a thermocouple 21 is inserted into this insertion hole 30. However, in this example, it does not carry out fixing the tip of a thermocouple 21 with glass etc. in the insertion hole 30. Moreover, in this example, it uses as a thermocouple 21 itself thermometry machine.
[0027] According to this example, in addition to the effectiveness mentioned above, the following effectiveness can be further done so. That is, also in this example, a thermocouple 21 can be insulated by cylindrical object 11C which consists of a minerals insulating material. Therefore, this example can also prevent **** by the RF generator and the high voltage power supply, and induction too. Moreover, also in this example, a thermocouple 21 is isolated from the ambient atmosphere in a container by cylindrical object 11C. Therefore, as container internal pressure mentioned above, even if it changes rapidly, as for the measured value by the thermocouple 21, it is not influenced of this pressure fluctuation.
[0028] Furthermore, if it thinks as compared with the example of drawing 1 and drawing 3 , since the hollow sheath 20 does not intervene between a thermocouple 21 and the ceramic base 3, the measurement temperature which reflected the much more actual value correctly can be acquired. and the tip of the hollow sheath 20 -- a bag -- since processing stopped tubular is quite difficult, it becomes the cause of a yield fall. On the other hand, since the configuration which omitted the hollow sheath, then such comparatively difficult processing become unnecessary, the yield improves.
[0029] Drawing 6 is the sectional view showing the condition of having attached the heating apparatus concerning the example of further others of this invention in the container. The same sign is given to the same member as what was shown in drawing 4 and drawing 8 , and the explanation is omitted. In this example, the tip of a thermocouple 21 is inserted into the insertion hole 30, the perimeter is surrounded by cylindrical object 11C, and it isolates from the ambient atmosphere in a container. Therefore, about this part, drawing 4 and the same effectiveness as the example of drawing 5 can be acquired.
[0030] Next, it actually joined to the ceramic base 3 about cylindrical object 11C which surrounds the thermocouple 21 as shown in drawing 4 - drawing 6 . That is, the insertion hole 30 of the shape of a longwise cylindrical shape which carries out opening to a tooth-back 6 side was first formed in the predetermined location of the disc-like ceramic base 3. The diameter of the insertion hole 30 was set to 3mm, and the depth was set to 12mm. Both the ceramic base 3 and cylindrical object 11C were formed from the silicon nitride ceramics, and the resistance heating element 4 was formed from molybdenum. The bore of cylindrical object 11C was set to 6mm, the outer diameter was set to 9mm, and the outer diameter of a flange 13 was set to 15mm. And glass junction of cylindrical object 11C was carried out at the ceramic base 3.
[0031] However, in this case, the grinding process of the part for the joint of cylindrical object 11C and a tooth back 6 is carried out first, and they are both surface roughness. It could be 0.8 or less s. Moreover, the fine particles for glass of the following component were prepared. 2:30 % of the weight of SiO(s), Si3N4 : 10 % of the weight, aluminum 2O3 : This powder was mixed Y 203:30% of the weight 30% of the weight, and the binder was added, and it distributed, and fabricated in the shape of a

tape. And this tape was cut according to the configuration of the plane of composition of a flange 13, and the tape 31 after cutting was put between the plane of composition of a flange 13, and the tooth back 6. And using the fixtures 32A, 32B, and 32C made from an alumina, alignment of the center line of cylindrical object 11C was mostly carried out to the core of the insertion hole 30, and the dead weight 33 was put on the upper limit side of cylindrical object 11C. The ceramic heater was put in into the electric furnace in this condition, and it heat-treated at 1500 degrees C under nitrogen-gas-atmosphere mind for 1 hour. This joined cylindrical object 11C to the ceramic base 3. Then, it confirmed about insulation. And pressure-proofing with a container flows in one direction 1kV or more of alternating currents in 800 **. The insulation of 1 M omega or more of resistance was checked in 500MV.

[0032] Although the wafer heating surface was placed upside down and processed in the above-mentioned example by supporting from the bottom by the pin which does not illustrate a wafer, it is good as for facing up in a wafer heating surface. In the above-mentioned example, although the heating apparatus of this invention was attached in the wall surface by the side of head lining of a container, it can also attach in the bottom wall surface and side attachment wall of a container. In addition, although it is desirable to suppose that it is disc-like as for the configuration of a ceramic heater in order to heat a circular wafer equally, it is good also as the shape of other configurations, the shape of for example, the square board, and the hexagon-head board etc.

[0033] As a tube-like object, a square tube-like object [besides the above-mentioned cylindrical objects 11A and 11B and 11C] and 6 rectangular-pipe-like object etc. can be used. As a long picture-like electrode member, electrode members, such as the shape of a rectangular-head cylinder besides electrode member 8A of the shape of the above-mentioned round bar and 8B and hexagonal bars, cylindrical, and a **** wire, can be used. The heating apparatus of this invention is applicable also to a plasma etching system, an optical etching system, etc.

[0034]

[Effect of the Invention] According to this invention, in order to heat directly the wafer with which the ceramic heater was installed in the container through a plate, thermal efficiency is high, and since a ceramic heater consists of a ceramic base with which the resistance heating element was laid underground, contamination like [in the case of a metal heater] is not produced. And it does not connect with the electrode member of others [member / which this deposition film was intercepted with the tube-like object even if the deposition film of conductivity / tooth back / of a ceramic heater / generated, since at least one of electrode members was surrounded with the tube-like object, and the end of this tube-like object was airtightly joined to the ceramic base and the seal also of between a container and tube-like objects was carried out airtightly, and was surrounded with the tube-like object / electrode] too hastily. Moreover, there is also no fear of discharge between the electrode members and containers which were surrounded with the tube-like object, and a short circuit. Furthermore, since the electrode member surrounded with the tube-like object is not exposed to the space in a container, neither the corrosion of this electrode member and a massive terminal nor the contamination in the container by this is also produced.

[0035] Moreover, since a thermometry machine is surrounded, the end of this tube-like object is joined to a ceramic base by the tube-like object which consists of a minerals insulating material and the seal also of between a container and tube-like objects is airtightly carried out with it, even if it uses the RF generator for semiconductor devices, and a high voltage power supply, **** by it and induction can be prevented. Moreover, since this metal is not exposed to the space in a container even if it forms a thermometry machine with a metal, neither the corrosion of a thermometry machine nor the contamination in the container by this is also produced. And since the thermometry machine is isolated from the ambient atmosphere in a container with the tube-like object, even if it changes container internal pressure rapidly at the time of semi-conductor manufacture, as for the measured value with a thermometry machine, it is not influenced of this pressure fluctuation.

[Translation done.]

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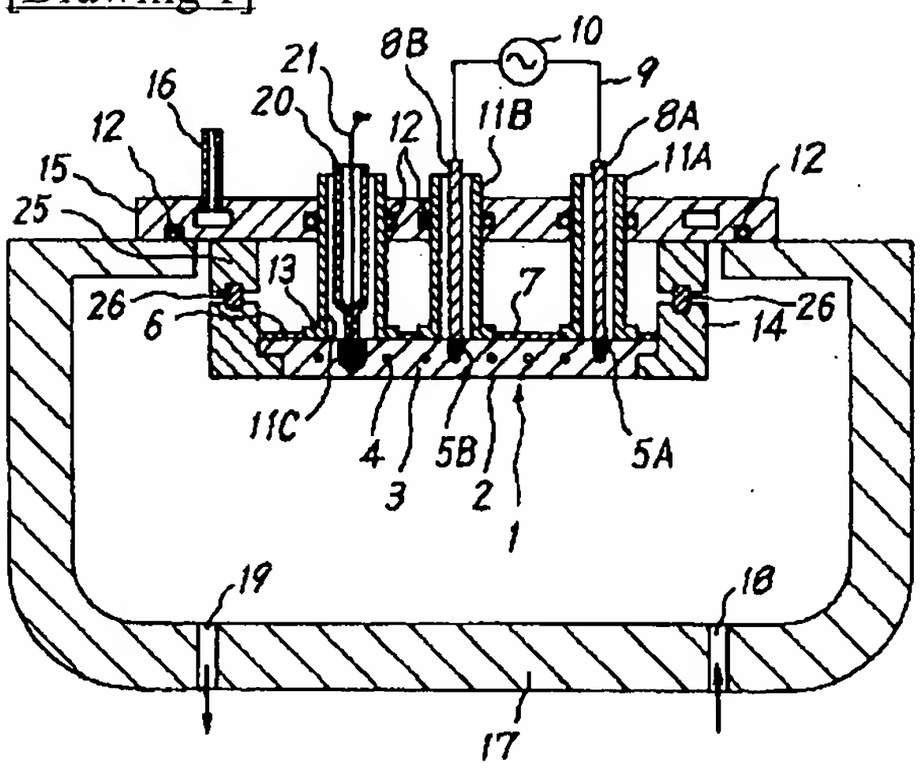
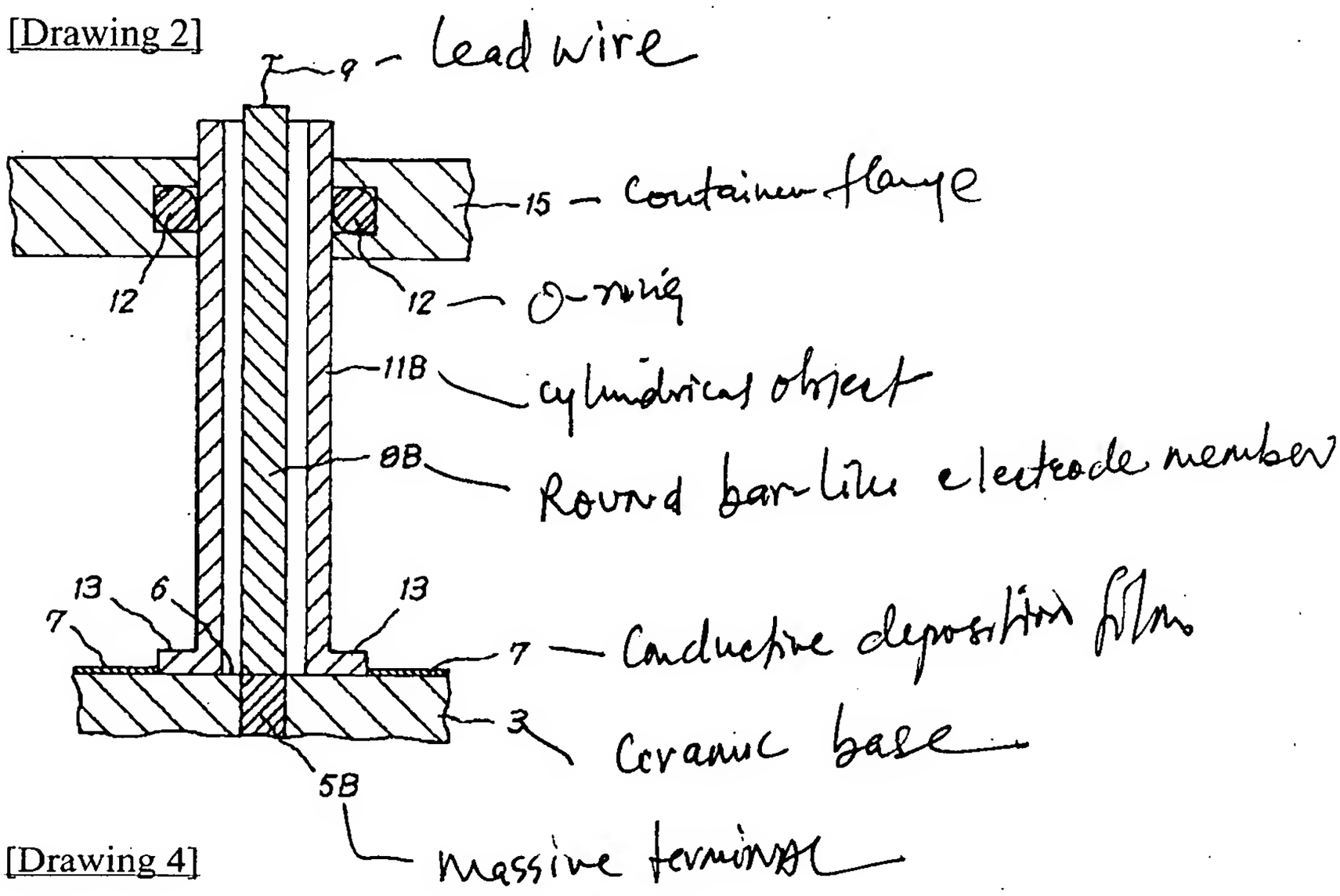
DRAWINGS

[Drawing 1]



[Drawing 2]



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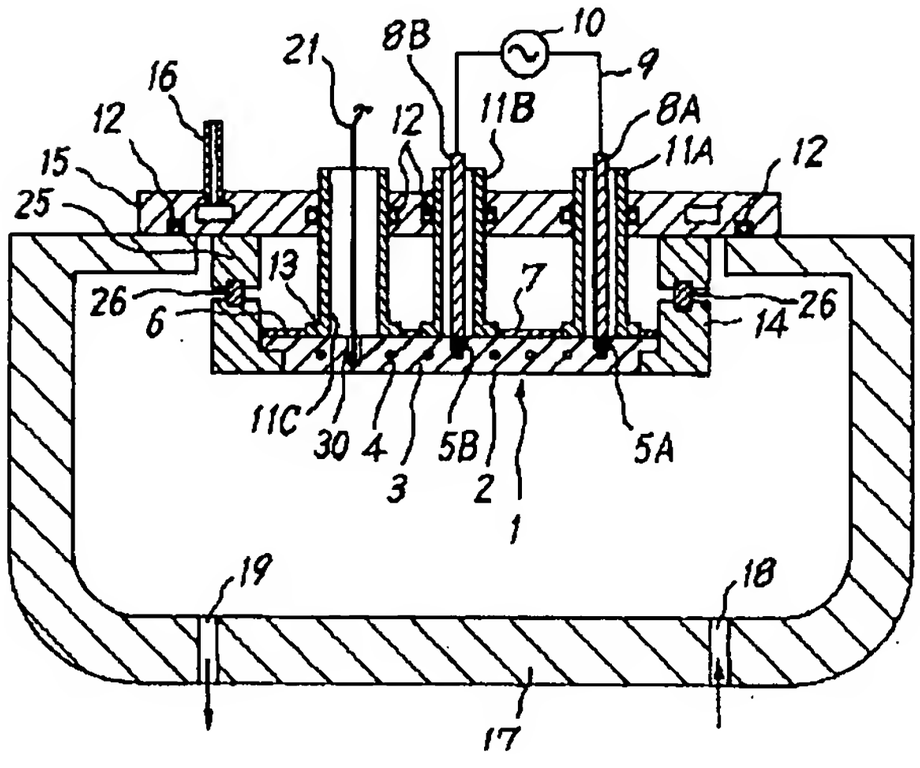

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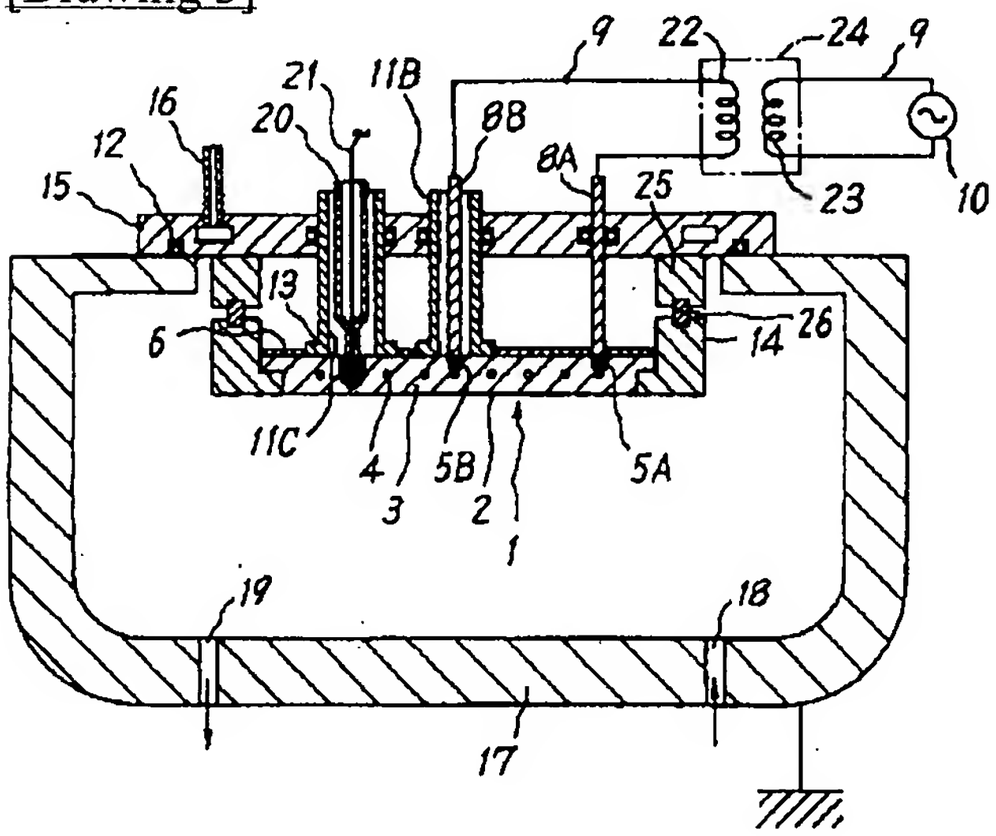
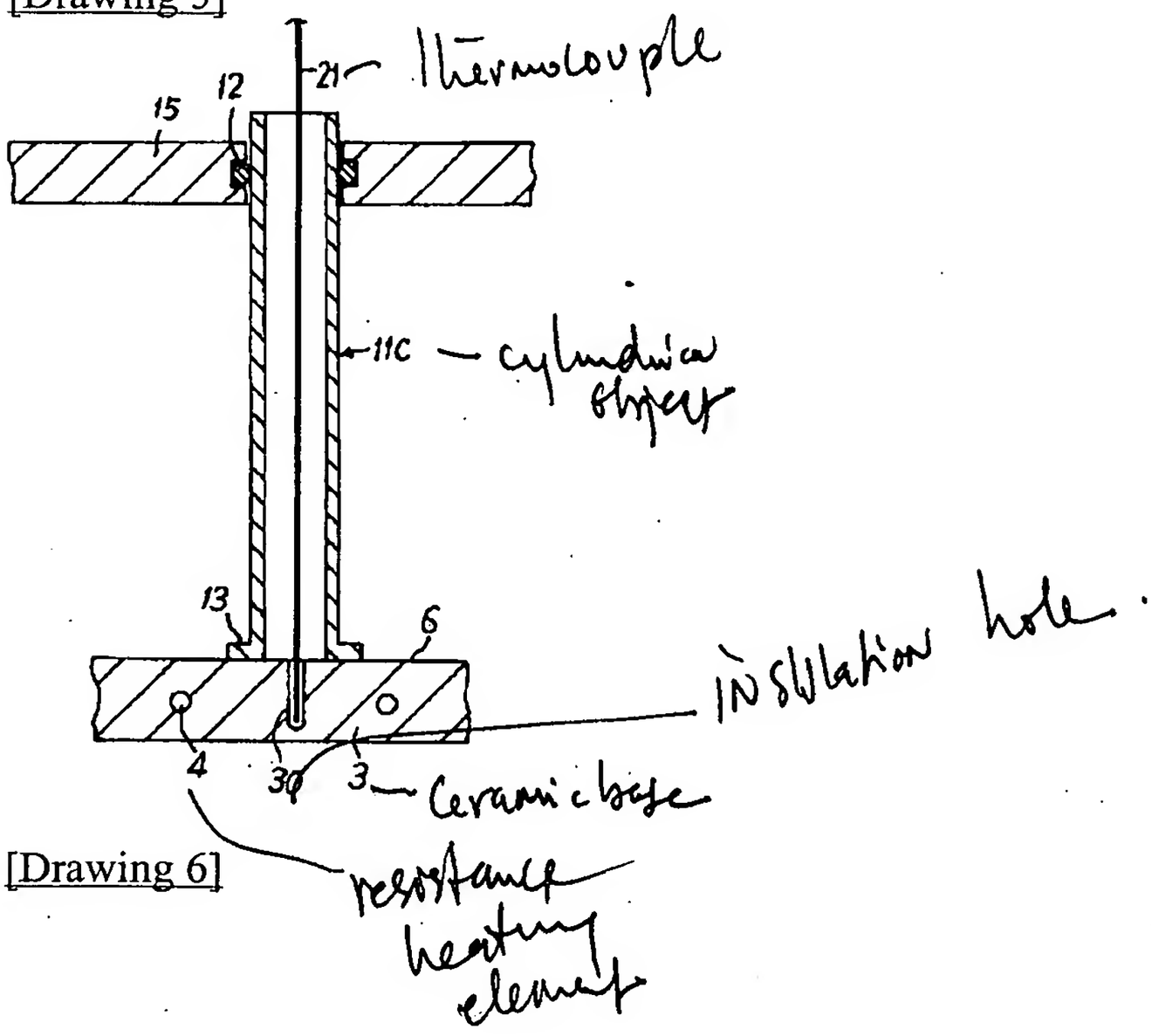
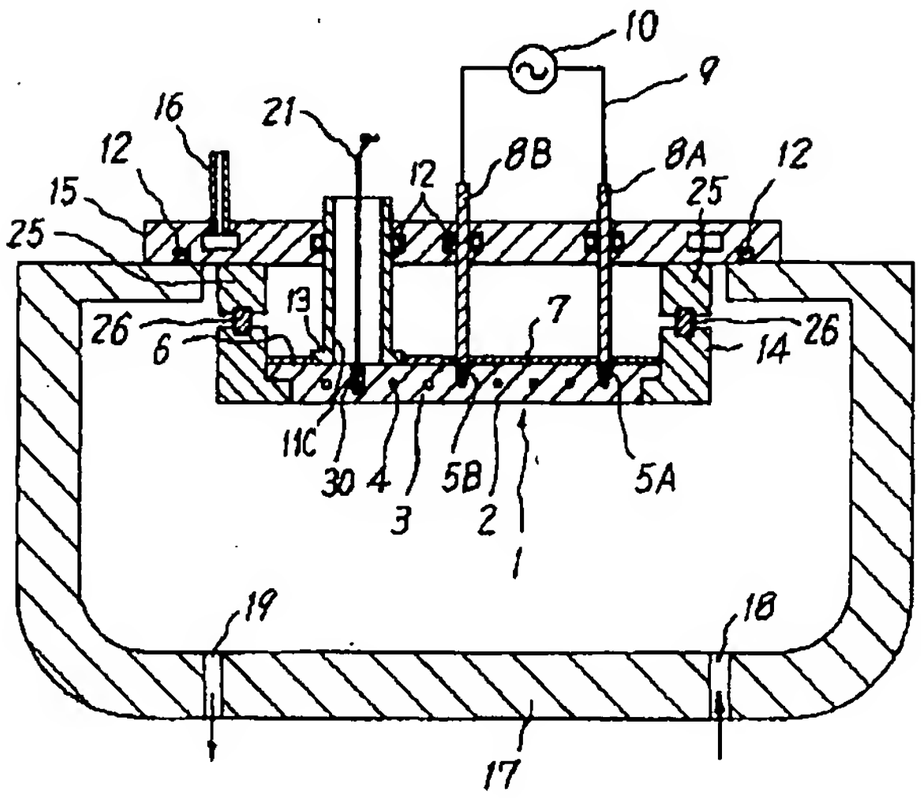


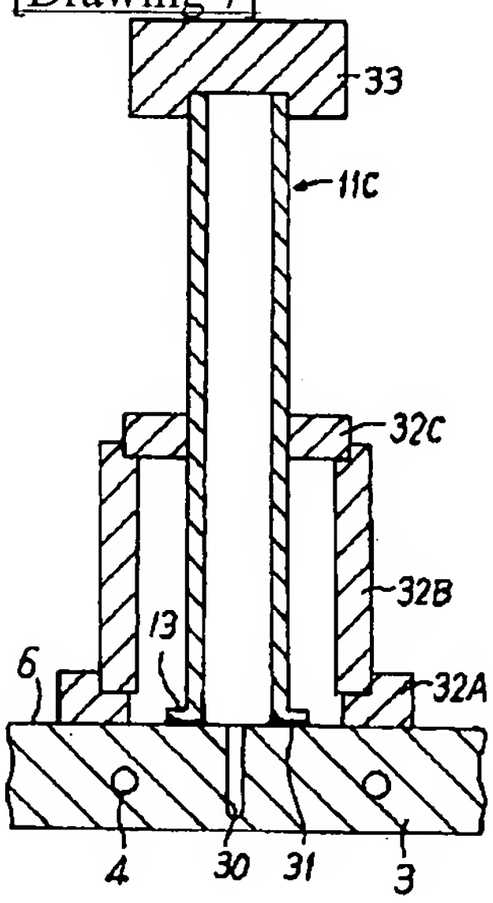
[Drawing 5]



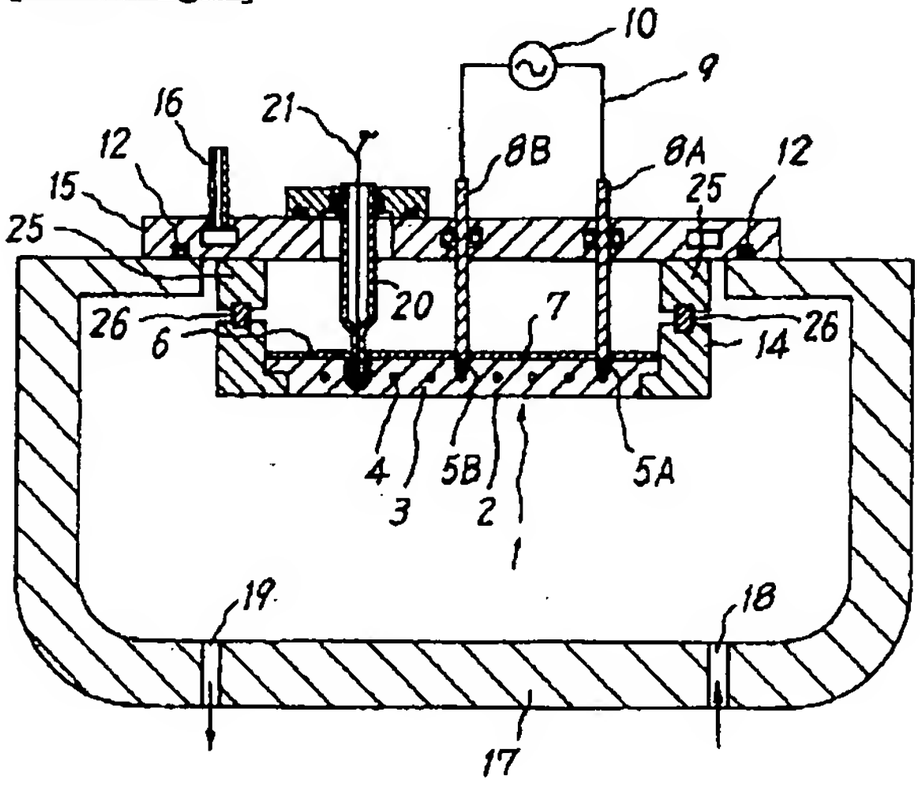
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]